REMARKS

Present Status of the Application

The Office Action objected the drawings, specification and claims because of minor incorrect and unclarity. The Office Action also rejected all presently-pending claims 1-18. Specifically, the Office Action rejected claims 1 and 4 under 35 U.S.C. 102(b), as being anticipated by Yagi (JP 6-104459, 4/15/1994). The Office Action also rejected claims 2, 3 and 5-18 under 35 U.S.C. 103(a) as being unpatentable over Applicants' admitted prior art in view of Yagi. Applicants have amended the specification to overcome the objection and have withdrawn claims 1-11 and have amended claims 12-15 to improve clarity. No new matter has been added to the application by the amendments made herein. After entry of the foregoing amendments, claims 12-18 remain pending in the present application, and reconsideration of those claims is respectfully requested.

Summary of Applicant's Invention

The Applicant's invention is directed to a string diode structure having bidirectional conduction capability that can simplify the design of electrostatic discharge protection circuits and reduce area occupation of the electrostatic discharge protection device. The diode string structure according to the invention comprises a starting end and a terminal end. Notably, at the starting end of the diode structure, there is a first doped region located within a first well region with a second conductive type in a substrate with a first conductive type. Further, the rest portion

of the diode string is constructed by a plurality of diode structures series connected to each other and all the diode structure are located within the first well region. Each diode structure comprises a second well region, a second doped region and a third region, wherein the second doped region and the third region are located within the second well region and the second doped region and the third doped region are detached from each other. Since all the diode structures in the diode string structure are located within the same first well region and no additional well region with a conductive type other than that of the second well region is formed to enclose each diode structure respectively, the size of the diode string structure is relatively small.

Discussion of objections

According to the Office Action, the drawings were objected because in Fig. 5, the leakage current curves (510b-540b) appear to be misplaced horizontally with respect to the current curves (510a-540a). Applicants respectfully traverse this objection and consider that Fig. 5 of the invention is correct and it is unnecessary to do any amendment. Further, the Office Action also objected the specification of the invention because of the informalities and/or defects found in Paragraphs 0033 and 0042. In response thereto, applicants have amended the descriptions of the relationship between the elements of the diodes shown in Figs. 2 and 3 in Paragraphs 0033 and 0042 respectively. The Office Action further objected the claims 1-18 of the invention because of the informalities and/or defects. In response thereto, applicants have withdrawn claims 1-11 and have amended claims 12-15. No new matter has been introduced to the application and the claims by the amendments made herein.

Discussion of Office Action Rejections

The Office Action rejected claims 1 and 4 under 35 U.S.C. 102(b), as being anticipated by Yagi (JP 6-104459, 4/15/1994). The Office Action also rejected claims 2, 3 and 5-18 under 35 U.S.C. 103(a) as being unpatentable over Applicants' admitted prior art in view of Yagi.

Applicants respectfully traverse these rejections but have withdrawn claims 1-11 and have amended claims 12-15 to clearly define the diode and the diode string structure according to the present invention. As amended, claims 12-15 respectively recite:

> Claim 12. A diode string structure having a starting end and a terminal end, comprising:
> a substrate with a first conductive type;
> a first well region with a second conductive type located within the substrate;
> ***a first doped region with the second conductive type located within the first well region at the starting end of the diode string, wherein the first doped region is adjacent to the surface of the substrate and the first doped region is coupled to a drain terminal; and***
> at least two diode structures located within the first well region, wherein each diode structure is detached from the first doped region and each diode comprises:
> a second well region with the first conductive type located within the first well region; and
> a second doped region with the first conductive type and third doped region with the second conductive type located within the second well region and adjacent to the surface of the substrate, wherein the third doped region and the second doped region are detached from each other.
>
> Claim 13. The diode string structure of claim 12, wherein for each diode structure neither the first diode structure at the starting end of the diode string nor the last diode structure at the terminal end of the diode string, there is a post diode structure directly located next to the diode structure in the diode string and ***the third doped region of the diode structure is coupled to the second doped region of the post diode structure.***

> Claim 14. The diode string structure of claim 13, wherein ***when the diode is located at the starting end of the diode string adjacent to the first doped region, the second doped region of the diode is coupled to the first doped region and the third doped region of the diode is coupled to the second doped region of another diode next to the first diode in the diode string.***
>
> Claim 15. The diode string of claim 13, wherein ***when the diode is located at the terminal end of the diode string, the third doped region of the diode is coupled to a ground terminal and the second doped region of the diode is coupled to the third doped region of another diode prior to the diode-in the diode string.***

(***Emphasis added***). Applicants submit that claims 12-15 patently define over the cited art for at least the reason that the cited art fails to disclose at least the features emphasized above.

The present invention is directed to a diode string structure, wherein the diode string structure has a starting end and a terminal end. The diode string structure of the present invention is located in a first well with a second conductive type in a substrate with a first conductive type. At the staring end of the diode string structure of the present invention, there is a first doped region with the second conductive type located in the first well region and the first doped region is coupled with a drain terminal. Moreover, for the rest part of the diode string structure, there are a plurality of diode structure, and each diode structure includes a second well region with the first conductive type, a second doped region with the first conductive type and a third doped region with the second conductive type. For each diode structure neither the first diode structure adjacent to the starting end of the diode string structure nor the last diode structure at the terminal end of the diode string structure, there is a post diode structure immediately next to the diode structure. Therefore, the third doped region of a diode structure in

the diode string structure is coupled to the second doped region of the post diode structure of the diode structure. Furthermore, the last diode structure in the diode string structure at the terminal end of the diode string structure is coupled to a ground terminal through the third doped region of the last diode structure. Additionally, the first diode structure immediately adjacent to the starting end of the diode string structure is coupled to the first doped region through the second doped region of the first diode structure. Since all the diode structure and the first doped region are located in a single first well region and there is no need to additionally form well region with the second conductive type for each diode structure and for the first doped region, the size of the diode string structure is reduced.

Yagi et al. disclose a semiconductor device having a PNP bipolar transistor composed by an N-type well region 13/18 and a P-type well region 15/20 within the N-type well region 13/18. They further mention that the base of the PNP bipolar transistor is coupled to an anode and the emitter of the PNP bipolar transistor is coupled to a cathode. That is, the electrode 35 coupling with both the N-type well region 13/18 and the P-type well region 15/20 is coupled with the anode and the electrode 36 coupling with another N-type well region 16/23 within the said P-type well region 15/20 is coupled with the cathode. Although Yagi et al. disclose a diode structure similar to that provided by the present invention, they do not teach the way to serially connect the diode structures. Yagi et al. also fails to suggest that when serially connecting the diode structures, only one N-type well region 13/18 is necessary to form in the substrate to enclose all the diode structure in order to decrease the size of the diode string structure.

Moreover, although the Applicants' Admitted Prior Art (AAPA) disclose a semiconductor device similar to the diode string structure of the present invention, the AAPA fails to teach to formed an extra well region to enclose all the string structure to decrease the size of the diode string structure. Neither do Yagi nor AAPA teach a way to reduce the size of the diode string structure. Therefore, even people skilled in the art will not think to modify Yagi referring to what disclosed in the AAPA to obtain a smaller diode string structure. Applicants respectfully submit that claim 12 is believed to patentably distinguish over the combination of the prior arts.

For at least the foregoing reasons, Applicant respectfully submits that independent claim 12 patently defines over the prior art references, and should be allowed. For at least the same reasons, dependent claims 13-18 patently define over the prior art as well.

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CONCLUSION

For at least the foregoing reasons, it is believed that the pending claims 12-18 are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Respectfully submitted,
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